

RRAM Switching Mechanism

S. T. Hsu¹ (shsu@sharplabs.com), W. W. Zhuang¹, T. K. Li¹, W. Pan¹, A. Ignatiev², C. Papagianni², and N. Wu²

1. Sharp Laboratories of America, Inc., 5700 NW Pacific Rim Blvd., Camas, WA, 98607
2. Texas Center for Superconductivity and Advanced Materials, University of Houston, Houston, TX 77204-5002

Abstract

The electrical pulse induced reversible (EPIR) resistance change of PCMO thin film non-volatile memory resistor is an excellent non-volatile memory element for resistor random memory array (RRAM). We have studied the properties of RRAM memory cells in terms of electrical pulse width, temperature dependence of the resistance, trap states effects, and electrode effects. The PCMO material is deposited using a MOD, PVD, or PLD process. The MOD PCMO is a small grain polycrystal material. The PLD PCMO thin films have a single crystal structure, while a PVD PCMO thin film is a large grain polycrystal material. The experimental results clearly show the electrical pulse induced reversible non-volatile resistance change is neither due to interface effect, nor due to field induced electro-chemical migration process. In addition, there is no crystalline to polycrystalline phase change, nor metallic conduction filament formation caused by the resistance changes. The data clearly concludes the electrical pulse induced resistance increase is a current driven process and is due to the localization of valence electrons by electron-electron interaction. The electrical pulse induced reduction of resistance is a field driven process and is due to de-localization of localized valence electrons by high electric field effect. We will present the experimental data on the pulse width dependence of the resistance change, the temperature dependence of the resistance, and the charge transport properties in PCMO thin film of different crystalline structures in detail to support the proposed RRAM switching mechanism.